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Data : May 29, 1997; Time: 16:30
Pages: 4 (Letters with originals follow: 4 pages + 5 Appendix Encl.)
Re: Final REPORT on EOARD Special Contract Program

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FINAL REPORT *

EOARD Contract F61708-96-W0189 (Special Contract Program SPD 96-4039, published in AFOSR Pamphlet 64-1) - Prof. Dr. A. Petrakiev

Title: PRELIMINARY CALCULATION AND PREPARATION OF INDUCED GAMMA EMISSION EXPERIMENT WITH ^{119m}Sn

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I. IntroductIon

Our previous IGE investigations [1-10] are connected mostly with Kamenov and Bonchev's idea [11], that stimulated gamma emission is po-ssible between two excited levels (upper m and lower n with corresponding life-times $t_m >> 1$ sec and $t_m << 10^{-6}$ sec). Some isomers like ^{125m}Te, ^{119m}Sn are very suitable for IGE. From our point of view the best candidate for Gamma laser is ^{119m}Sn. Systematically calculations, experiments, comparisons and evaluations are need. Practically ^{119m}Sn is not enough study for IGE, but big number of Mossbauer investigations, using this isotope are reported and published. Some of them are good basis for our evaluations and preparation of IGE experiment [12-14]. In time of developing of this project (1996 - May 1997) some number of lectures and scientific reports connected with IGE, X-ray and Gamma-ray lasers was presented and published from the author and co-authors [15-21].

*/ The "Interim Report" from 27/ 09/ 1996 is an inseparable part of this Final Report.

II. Plan of Work-Phase I/2

1. Synthesising of different suitable substances of *Sn* and preparations of samples - active elements.

2. Preliminary evaluations of recoilless factor f_m for Moessbouer transition for SnO_2 and $CaSnO_3$, if we find out money for substances (sources) and conditions for realising of synthesing technology and experiments*/.

3. Preliminary studding of synthesising technology for different suitable substances of *Sn* and preparation of active elements for a future irradia-tions in nuclear reactor with termal neutron flux $\Phi > 10^{14}\ cm^{-2}\ sec^{-1}$

4. Direct Mossbouer preliminary evaluation of recoilless factor (for the level 23,8 keV) and for different technology of preparation of samples and active elements.

5.Evaluation of differences of recoilless factors at transmission and scattering for different substances.

III. Results from the Execution of the Plan

1. For synthesising of different suitable substances of *Sn* and samples preparation two methods have been used : mixing and heating of compounents and second - mechanic-chemical synthesis in a mill. A natural *Sn* was used in both cases. Preliminary experiments show that mechanic-chemical method is not sufficiently good for this kind experiments. Additional finances are need for continuation of this investigations */.

2. This item we have executed in part and presented in *Interim report.* Preliminary theoretical calculation of recoilless factor f_m (Mossbauer) and f_s (stimulated) for the most suitable substances was made using the equation

$$f_s = \exp\left[-\frac{E_s^2}{E_m^2}\ln\frac{1}{f_m}\right] \qquad \frac{E_s^2}{E_M^2} \simeq 9{,}47$$

$(T = const)$

3. For preparation of samples and active elements is need *Sn* containing more than *94 %* ^{119m}Sn. It is better to used SnO_2 but not *Sn O*. Better result can expected with chemical composition $CaSnO_3$ *and* Mg_2Sn. Additional experiments and financial support are need for chemicals and equipment's for finishing of this experiments. The enrichment of excited nuclei of ^{119m}Sn *is strongly need* at IGE experiments*/.

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*/ Because I change my place of of job from Sofia University to Bourgas University (about 400 km far from Sofia) we have not available enough equipment's, chemical compositions and financial support for experiments.

4.Preliminary evaluation of recoilless factor for $Ca\ SnO_3$ (level 23,8 keV) is ~ 0.67 + 005 at room temperature and f_s = 1.4925. For the level 65 keV and room temperature f_s ~ 0.052 and at helium temperatures f_s ~0.1. Therefore this composition can be used for stimulated emission experiments, but preliminary enrichment (both - chemical and radiochemical) are need.

5.The recoilless part of the Messbauer radiation for one and the same substances and condition was considered as yet the same in absorption, as well as in scattering. We report and offer a possible explanation of the differences in the possibility of recoilless interaction in scattering and absorption observed by us in scattered geometry, in some cases a specific shape of the recoilless scattered line is observed as well (the source $BaSn\ O_3$, the scatterer $CaSnO_3$ and the absorber SnO_2). Such an effect of differences is observed also by Bonchev, Kamenov, Rus-sanov, Angelov and Mandjukov .Two facts were established : a/ the difference in the probability of recoilless interaction is scattering f'' and absorption f' ($f'' > f'$); b/ a specific of the recoil line in some cases. A possible explanation of these facts was found.

IV. Additional Studies and Results

Additional Moessbouer Studies of the composition $SnTe_3O_8$ was made. The probability for recoilless absorption f' was not determined but the observed high Moessbauer effects show that f' has a high value. Comparative estimates of f' with those of stanates show that its values is ~0.6.

V. Conclusions

1. Theoretical cross sections for IGE for ^{119m}Sn about 4 times better them ^{125m}Te and linear coefficient for total absorption $\mu_{Sn} > \mu_{Te}$ for SnO_2 and $BeTe$.
2. Preliminary calculations of recoilless factor f_s (stimulated) for $^{119\,M}Sn$ and comparisons with $^{125\,m}Te$ show that this factor is more high for Sn. At equally concentrations for this two isomers is better to used $^{119\,m}Sn$ for IGE.
3. The cross section for activation with reactors termal neutrons for Sn is σ_n ~ *0.04 bn,* which is 100 times less than cross section σ_n for Te.
4. The determination and preparation of most suitable chemical composi-tion for IGE and Mossbauer experiments with $^{119\,M}SN$ IS RELATIVELY MORE EASY, BECAUSE COMPOUNENTS ARE NOT TOXIC IN COMPARISON WITH $BETE$
5. AT EQUALLY CONCENTRATIONS OF EXCITED NUCLEI K_o PER *CUBIC SANTIMETERS* THE PROBABILITY FOR REGISRTATION OF A DOUBLE-ENERGY & TRIPLE-ENERGY PEAKS IS BIGGEST FOR SN THAN FOR TE , DU TO BIGGEST CROSS FOR IGE AND BECAUSE RECOILLESS ENERGY FOR SN IS LESS THAN RECOILLESS ENERGY FOR TE, ESPECIALLY FOR SNO_2 AND $BETE$.
6. Now is time for IGE experiment on nuclear reactor with termal neutron flux $\Phi > 10^{14}$ cm^{-2} sec^{-1} (ILL-Grenoble-France or Oak Ridge - USA)

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Encl: - 4 abstracts
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